



*Padilla Bay*

National Estuarine Research Reserve

# THE ESTUARY GUIDE

## LEVEL 2

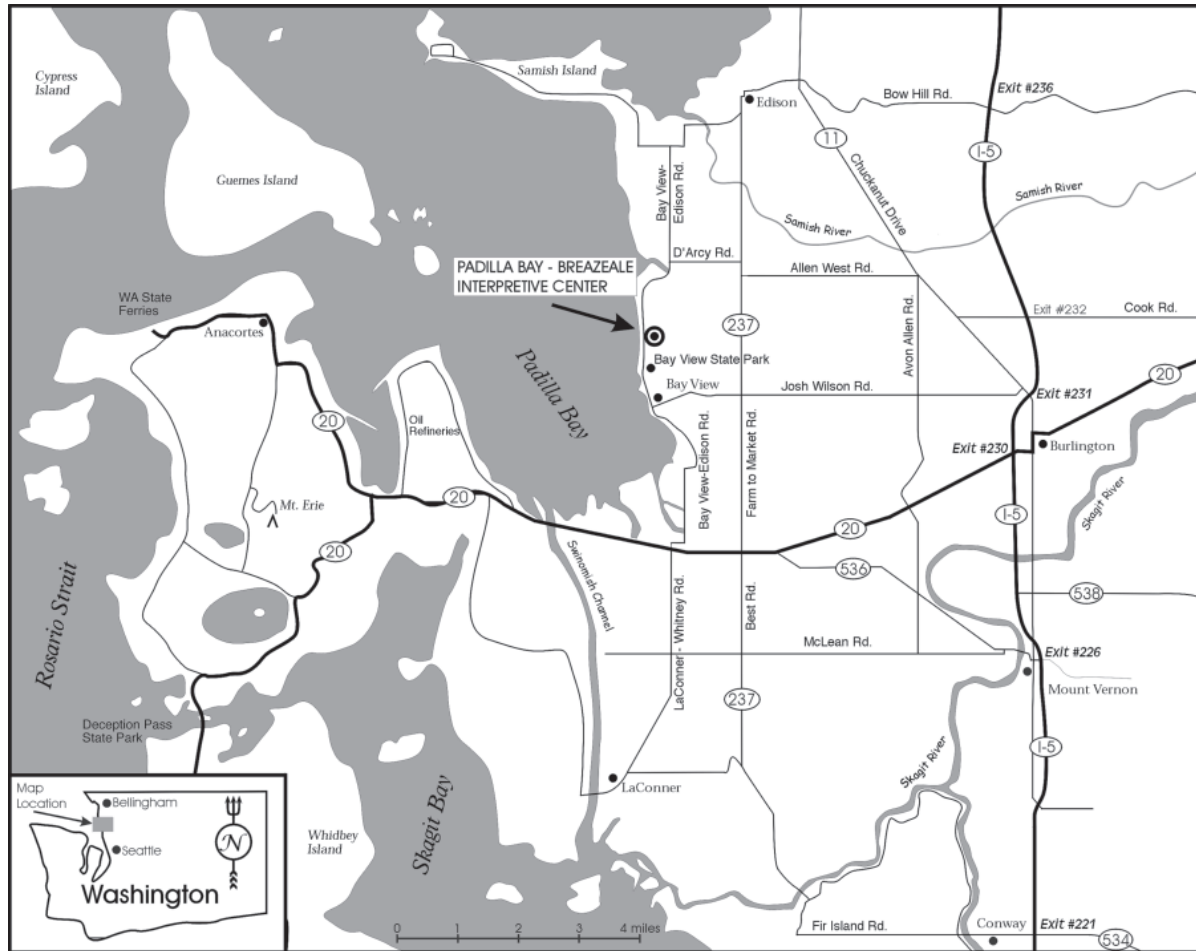
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Publication No. 89-58  
Revised 1999





# Table of Contents

Introduction .....	5
Teacher Checklist .....	6
A Bit About Estuaries... ..	7

## **Pre trip Activities**

Introducing Your Class to Estuaries .....	11
A Bit About Estuaries — Student Reading .....	12
Watershed Search .....	16
Vocabulary .....	18
Crossword .....	19
Estuary Word Search .....	20
Puzzle Keys .....	21
Writing an Estuary Story .....	22
Learning About Tides and Tables .....	23
Make a Food Chain .....	24

## **On Site Activities**

Important Notes .....	27
Schedule for the Estuary Program .....	28
Parent Page .....	29
Aquaria Inquiry .....	30
On Your Own at the Beach .....	32
Map of Bay View State Park .....	33
Scavenger Hunts .....	34

## **Post trip Activities**

### **Art**

Critter Creations .....	38
Afternoon in an Estuary .....	39

### **Writing**

What's Happening Here? .....	41
Estuary Stories .....	42
Salmon Gazette .....	43





# Table of Contents

## **Post trip Activities (cont.)**

### ***Science***

Salt Water - Fresh Water .....	45
Salmon Maze .....	46
Food Chain Game .....	47
Amazing Facts Box .....	49
Estuary Community Dance .....	50
Is Dead Seaweed Garbage? .....	57

### ***Social Studies***

From Marsh to Marina .....	59
Changing Values .....	65
Making Good Decisions .....	67
Watershed Salmbassador .....	68
Drawing Your Own Water .....	75
Getting Serious about Cars .....	76
Perusing the Poisons .....	78

<b><i>More Ideas</i></b> .....	82
--------------------------------	----

### **Resources**

Children's Books .....	86
Magazines .....	86
Reference Books .....	87
Curricula .....	87
Places .....	90



# Introduction

This guide is designed for teachers of fourth through eighth grades to compliment a visit to the Padilla Bay National Estuarine Research Reserve. It is also a useful resource to anyone teaching about watersheds, estuaries, shorelands, and coastal resources.

It is divided into four sections:

- PRE-TRIP information and activities
- ON-SITE materials
- POST-TRIP ideas
- RESOURCES

A variety of activities is included, designed to weave together many subjects and many ways of learning. Our hope is that some will fit comfortably into your class work and with your unique style of teaching.

There is a wealth of beauty, humor and truths stranger-than-fiction out there waiting to be understood. May these beginning activities lead to a closer bonding between people and the natural world.



Padilla Bay has been designated as a National Estuarine Research Reserve, managed by the Washington State Department of Ecology in cooperation with the National Oceanic and Atmospheric Administration (NOAA). One of 25 reserves around the country, Padilla Bay is set up as a natural field laboratory for research and education, with the goal of enhancing public awareness of the value of estuaries and improving coastal resource management.



# Teacher Checklist

## Pre trip:

- ☐ Read through this curriculum packet.
- ☐ Arrange for adequate adult supervision. (We suggest one adult for every 5 to 8 children.)
- ☐ Prepare adults by giving them the Parent Page on page 27. Be sure drivers have the map on page iv.
- ☐ Make legible name tags for all.
- ☐ Emphasize the importance of warm outdoor clothing: warm jackets, rain gear, hats, and gloves during October - May. Snug boots or old shoes that tie are best for low tide dates.
- ☐ Consider using one or more of the pre-trip activities on pages 9 to 23. Prepared students benefit most from our program.
- ☐ If you will be visiting the beach at Bayview State Park on your own, please read through "On Your Own At the Beach" on page 30.

## On Site:

- ☐ Are your students wearing name tags?
- ☐ Please arrive at your scheduled time or call to let us know of a change.
- ☐ Enjoy!

## Post trip:

- ☐ Continue the estuary studies back in your classroom with some of the many activities listed on pages 37-83 of this curriculum.
- ☐ If you have suggestions for any improvements or changes we could make to our program, please write or call (360)428-1558.
- ☐ Our programs are supported by State and Federal funds as well as a non-profit foundation. We encourage groups to join or make a donation to:

**The Padilla Bay Foundation**  
PO Box 1305  
Mount Vernon, WA 98273



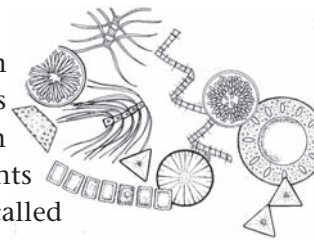
## A Bit About Estuaries ...

The Skagit River begins in the North Cascades. It tumbles down mountainsides, spills over waterfalls, runs past towns and under bridges, winds through the fertile Skagit Valley and eventually slows down as it nears its estuary, the Skagit Delta. An estuary: the place where a river meets the sea.

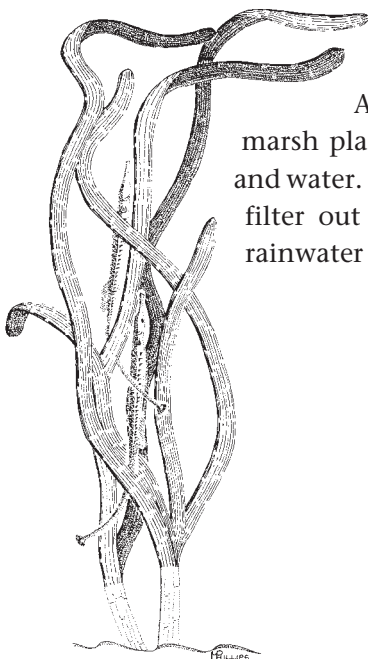
Estuaries are remarkable places, rich with treasures hidden to the casual observer. Life is concentrated here. The amount of plant material produced in an estuary far exceeds that of even our best-tended wheat fields. In turn, plants provide food and shelter for a myriad of animals. The bay is a veritable garden.

### Plants

The complex marine food web begins with phytoplankton, the tiny, free-floating plants that thrive in the shallow, sunlit, nutrient-rich water. Phytoplankton belong to a group of plants called algae. Larger algae are commonly called seaweeds.



Another producer is eelgrass, a flowering marine plant which carpets Padilla Bay. It offers food and shelter to the many animals that live on and among its blades. Eelgrass is valuable both as habitat while it is living, and as a food once it has died and decayed.



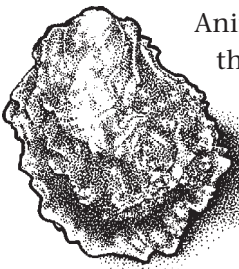
A third major group of plants consists of the salt marsh plants that form the transition zone between land and water. These specialized plants add nutrients to the bay, filter out toxins from land run-off, and soak up excess rainwater like a sponge.



## A Bit About Estuaries ...

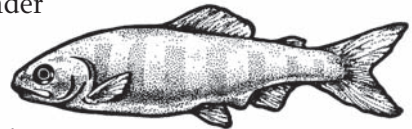
### Animals

The abundant plant life in an estuary attracts incredible numbers of animals, for it provides ample food and shelter. Estuaries can be a home, a nursery or a rest stop for migrating animals.



Animals such as oysters, clams, worms, crabs, and snails begin their life as zooplankton and settle down as they mature. These invertebrates provide food for larger animals such as birds and fish.

Salmon need to spend time in an estuary on their journey to the sea. The bay provides food, protective shelter, and a gentle transition stage from the fresh water to the salt. Juvenile Dungeness crab, herring, and flounder are some of the many animals found in large numbers in the shallow waters of the estuary.



Padilla Bay is located along a major flyway and hosts thousands of migrating birds, including shorebirds, ducks, brant geese, and raptors such as eagles and falcons. Some choose to winter here, while others continue southward.

“Estuary” comes from the Latin word “aestus,” meaning “tides.” Twice a day the tides fill and empty the bay. Seasonal cycles and daily fluctuations of tides, salinity and temperature create a unique environment that can be incredibly stressful to its inhabitants. Species that have adapted to the stresses tend to be numerous, attesting to the high productivity and natural wealth in an estuary.







## A Bit About Estuaries ...

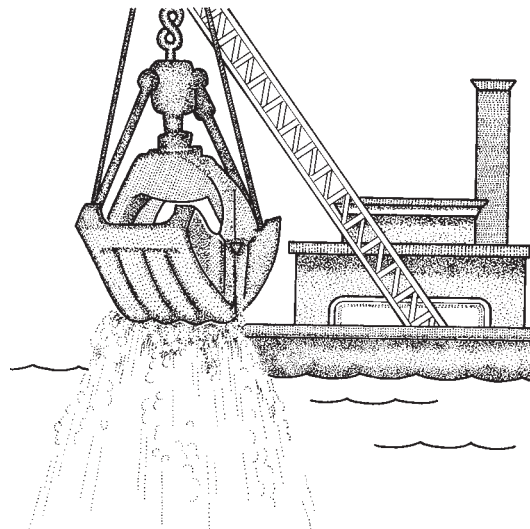
### People

People are much like birds. We, too, “flock” to estuaries for the natural resources, edible as well as aesthetic, and for the ease of transportation by land, water and air. The scenic backdrop for recreational activities and the peace and beauty at the water’s edge lure us. More than half of the U.S. population resides near an estuary. Most of the people in Washington state live on the coast, near an estuary (Puget Sound) - - and these numbers are steadily increasing.

Growing “appreciation” is a mixed blessing. Estuaries have been used and much abused in the past. Seen as barren and muddy wastelands, they have been targeted sites for dredging, diking, and dumping of wastes. Development is often accompanied by habitat loss, polluted runoff, increased erosion, and other water quality problems.

There are many things individuals can do to change this trend. Learning more about estuaries is a good first step, followed by a close examination of our own decisions and behaviors that affect estuaries.

We are glad you are here to learn with us.





## Pre Trip

### Pre trip Activities

Introducing Your Class to Estuaries .....	11
A Bit About Estuaries, student worksheet .....	12
Watershed Search .....	16
Vocabulary List .....	18
Word Games .....	19
Writing an Estuary Story .....	22
Learning About Tides and Tables .....	23
Make a Food Chain .....	24



by Tessa



## Introducing Your Class to Estuaries

Help your students get the most out of their field trip.

The activities in this section are designed to give students a common vocabulary and background on estuaries.

Begin with a discussion. Be sure your students know a simple definition of “estuary.” Look at a map of the United States and notice different shapes and sizes of estuaries. Share “water experiences,” comparing ocean, estuary, and fresh water beaches. Make a list of the questions that come up, and bring it to Padilla Bay. See how many questions can be answered after your trip.

Try some of the activities in this Pre-trip section. We especially recommend the Watershed Search on page 14 and the story writing activity on page 20.

Read *Pagoo* by Holling Clancy Holling. Detailed and accurate information about tidepool creatures is presented in a colorful, enjoyable story. (See Resources section for publisher information and other recommended books.)



## A Bit About Estuaries...

In the Pacific Northwest, rivers begin in the mountains. Water from rain, snow, and melting glaciers gathers in streams. It tumbles down mountainsides, spills over waterfalls, runs past towns and under bridges, and winds through rich farmland. The river finally slows down as it nears the sea. An estuary is the place where fresh water from the land meets the salt water of the sea.

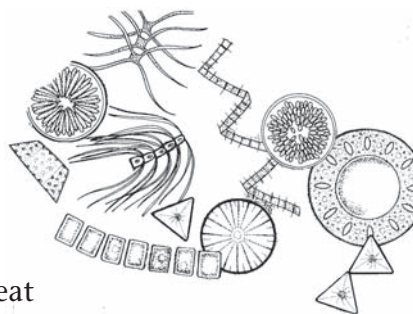
Estuaries are amazing places. They are home to all sorts of plants and animals that are specially adapted to live in a changing environment. Because of the tides, an estuary plant or animal may have to face hot, dry sun and cold salty ocean water. Waves can stir up thick mud, and torrents of fresh water after a hard rain can make the water “too fresh” for many animals. It's not easy to live in a place that changes so much, but for those that do survive, the estuary offers something else: food.

### Questions:

1. What is an estuary?
2. Why is it hard for animals to live in an estuary?

### Plants

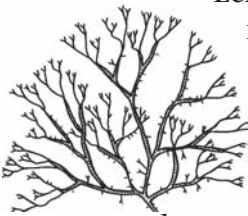
An estuary food web begins with the producers. Plants use sunlight energy for photosynthesis, combining carbon dioxide ( $\text{CO}_2$ ) and water ( $\text{H}_2\text{O}$ ) to make sugar and oxygen. The sunlight energy is stored in the plants which can be eaten and used by animals. Without photosynthesis, animals (including people) would have nothing to eat and nothing to breathe!





## A Bit About Estuaries...

Phytoplankton are the tiny, free-floating plants. Though they are microscopic, there are billions of them, and they are very important. Many small animals eat phytoplankton and it gives off much of our planet's oxygen.



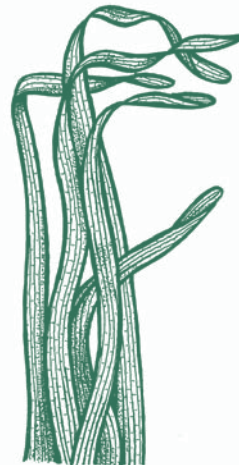
Eelgrass grows tall and thin and can be 8 or 10 feet tall. This is a flowering plant much like the grass in a field. It covers Padilla Bay like a green forest and is home to many animals that live on its blades.

A third type of plant is algae. Algae are sometimes called seaweed, and come in many shapes and sizes. Green algae can look like a flat leaf of lettuce or thin strands of hair. Brown kelp can grow to be 60 feet tall, with long, shiny blades that float in the currents. Some red algae has finely branched blades that look like lace.

Together, all these plants turn sunlight energy into food for animals living in the estuary.

### Questions:

1. Name 3 kinds of estuary plants.
2. Where do plants get their energy?
3. What gets energy from the plants?





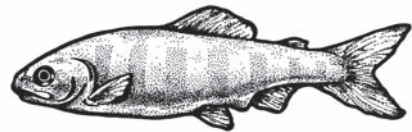


## A Bit About Estuaries...

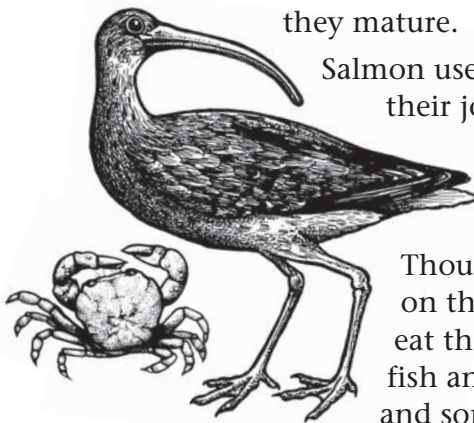
### Animals

An estuary provides important habitat for many animals. It can be a home, a rest stop or a nursery.

It is used as a home by animals like oysters, clams, worms, and snails that spend their whole lives in estuaries. They begin as free-floating zooplankton (tiny animals) and then settle onto rocks or into the mud as they mature.



Salmon use estuaries as a rest stop on their journey from the river to the sea. The estuary provides food, shelter, and a place for the young salmon to adjust to the salty ocean water.

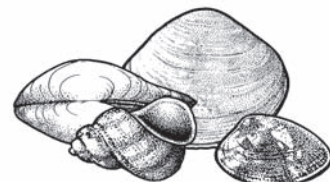


Thousands of migrating birds also stop at estuaries on their long trip between north and south. Some eat the eelgrass and algae, while others dive for small fish and shellfish. Some stay and spend the winter, and some just rest for a time and move on.

Many animals use the estuary as a nursery. Baby Dungeness crabs can hide from predators in the eelgrass meadows until they are old enough to move to deeper water. Harbor seal pups can grow up safely in the protected bay. Most marine animals are somehow connected to an estuary.

### Questions:

1. Name 3 ways animals use estuaries.
2. Name an animal that uses an estuary as a nursery.
3. Why do you think there are so many animals in an estuary?

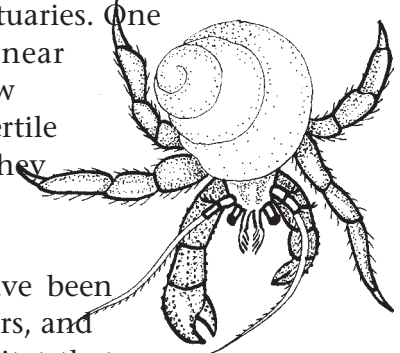




## A Bit About Estuaries...

### People

For thousands of years, people have lived near estuaries. One reason Northwest Native Americans settled near estuaries was the plentiful food. In the 1800s, new settlers from the east coast arrived. They found fertile soil for farming, and like the Native Americans, they hunted and fished in the estuaries.



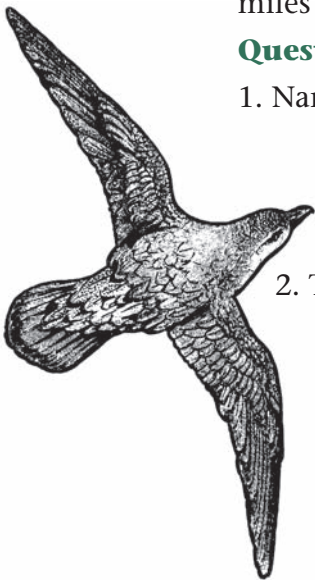
Today, people still use estuaries. Most of our largest cities are built on estuaries. Marshes have been drained, mud flats have been deepened for harbors, and shorelines have been changed. Much of the habitat that animals like salmon and crabs depend on is now gone.

You are connected to an estuary, too. A watershed is all the land that drains into a body of water. Your watershed eventually drains into an estuary, so what you and your family do on the land, and how you take care of your water affects your estuary. The water that rains on your yard or goes down the drain at your house probably ends up in the estuary.

If you visit a beach on Puget Sound, your actions can affect the estuary. Things like littering, leaving rocks overturned, and spilling gas from a boat can be harmful to estuary plants and animals. Whether you are right in the middle of an estuary or miles up the river, your actions make a difference.

### Questions:

1. Name 3 reasons people live near estuaries.
2. Think of 3 things you can do to keep estuaries healthy.





# Watershed Search

Follow these directions for the accompanying map. You will need blue, green, red and regular-leaded pencils.

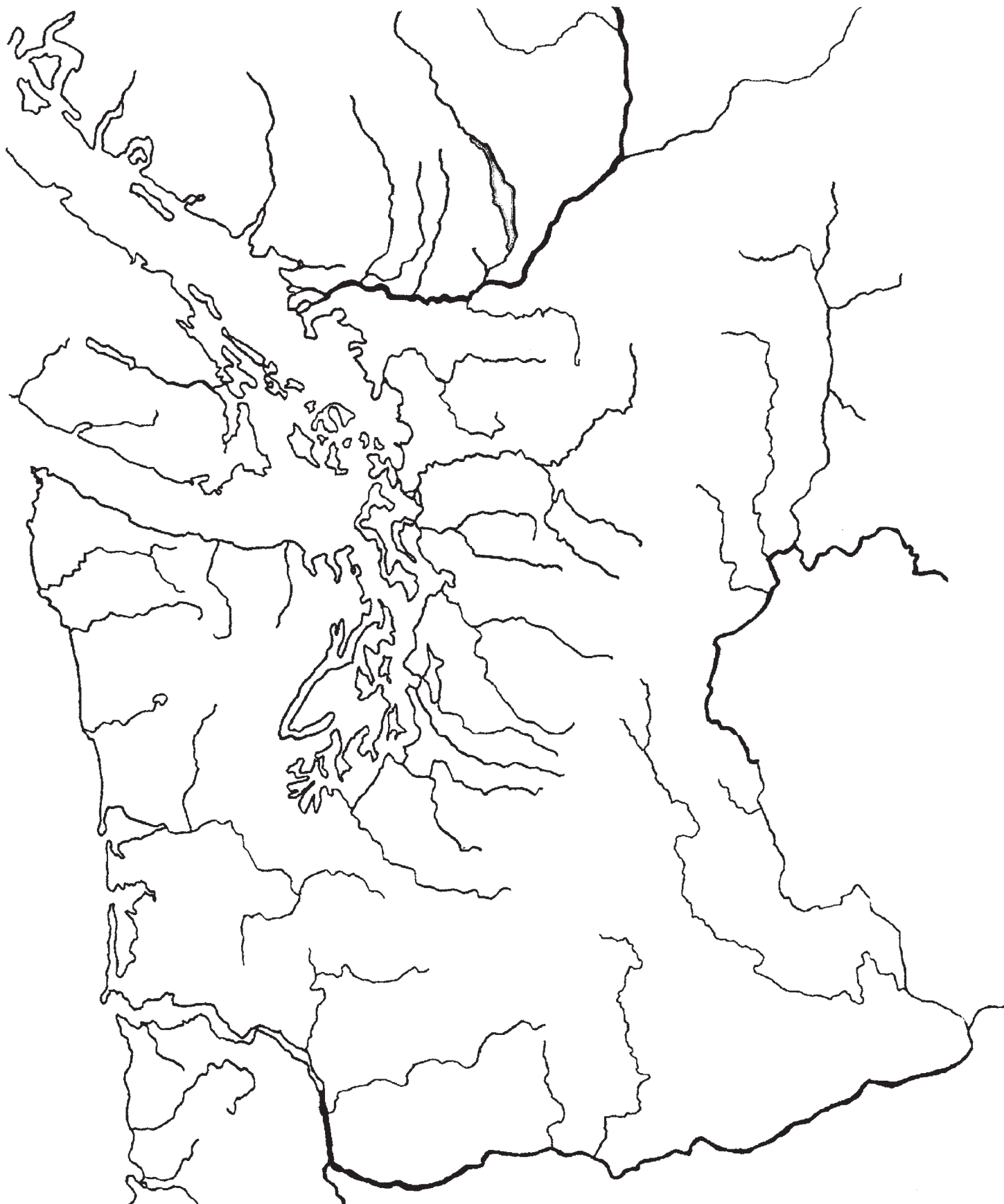


1. What is the name of your city? Locate and label it on the map and write it in with your pencil.
2. Find the river nearest to where you live. Label the mountain range where it begins.
3. In BLUE, trace the path of this river from its source to where it meets the sea.
4. With a GREEN pencil, color in the salt water near the mouth of that river.
5. In RED, circle where the freshwater river meets and mixes with the salt water from the ocean. This place is called an estuary.
6. Find and label these rivers and trace their paths using BLUE: Fraser, Nooksack, Skagit, Stillaguamish, Snohomish, Duwamish, Puyallup, Nisqually, Deschutes, Chehalis, Willapa, Columbia.
7. In RED, circle the estuaries where these rivers meet the salt water.
8. Label the following cities with your regular pencil: Portland, Olympia, Tacoma, Seattle, Everett, Stanwood, Bellingham, Vancouver, BC.
9. How many of these cities are near an estuary?
10. Find and label Puget Sound and the Strait of Georgia. This "inland sea" is one large estuary with many smaller estuaries in it. Color it blue.

As you may have noticed, many cities in Washington are built near an estuary. This is also true for many of the largest cities in the world.

**Bonus:** Look at a world map. List 10 large cities built on estuaries. Make a list of ways these cities might affect their estuary.

Adapted from South Slough National Estuarine Research Reserve





# Vocabulary

**estuary:** a place where fresh water mixes with salty sea water

**watershed:** all the land area that drains into a body of water

**habitat:** the place where a plant or animal lives

**food chain:** the transfer of energy (food) from plants to one or more organisms.

**food web:** overlapping and connecting food chains

**photosynthesis:** when plants use sunlight to change carbon dioxide and water into food and oxygen

**plankton:** tiny plants and animals that float freely in water

**phytoplankton:** free-floating microscopic plants

**zooplankton** (ZOH-plankton): free-floating microscopic animals

**detritus** (dee-TRY-tus): decaying bits of plants and animals

**producer:** something that makes its own food, such as a plant

**consumer:** an animal that eats plants or other animals

**predator:** an animal which captures and feeds on other animals

**prey:** an animal that is hunted by another for food

**decomposer:** an organism that breaks down dead materials such as leaves and animals

**scavenger:** an animal that eats dead and decaying things

**algae:** a type of plant without true stems, roots, and leaves — seaweeds

**diatom:** a type of single-celled phytoplankton

**filter feeder:** an animal, like a clam or oyster, that filters food from the water

**invertebrate:** an animal without a backbone

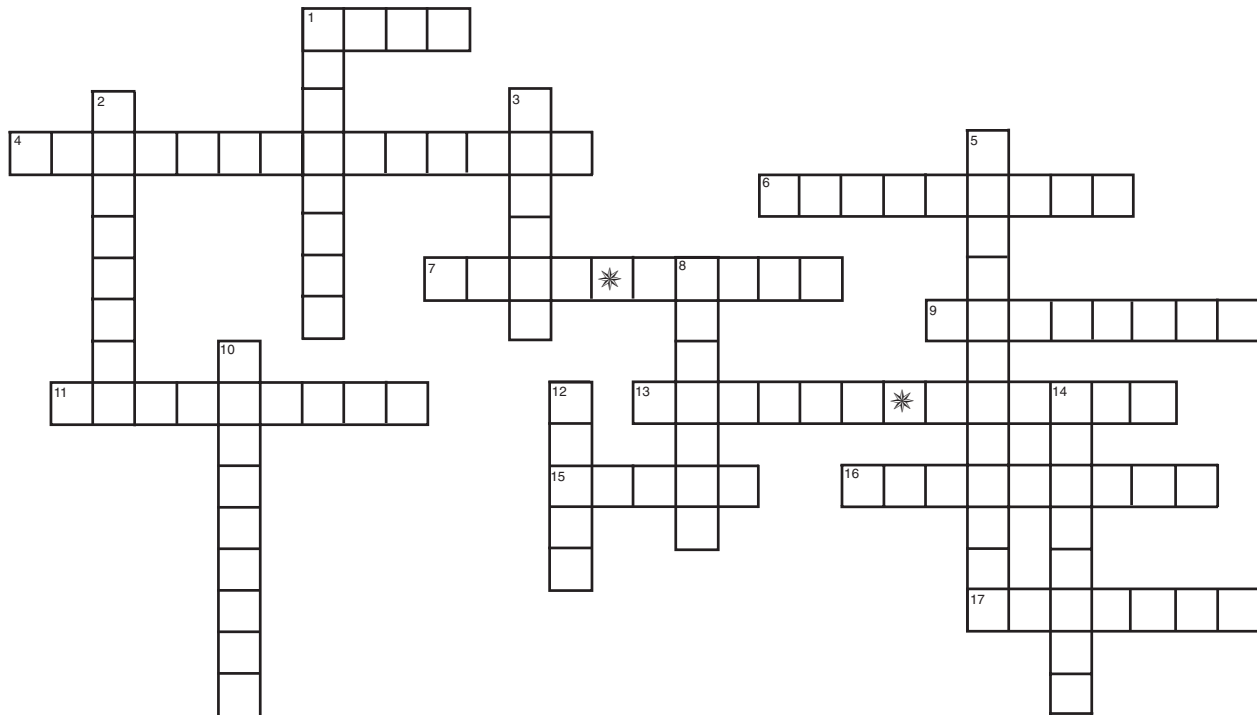
**migration:** the seasonal movement from one place to another

**wrack:** the tangled pile of dead plants left on the beach when the tide goes out





# Crossword



## Across

1. When small fish are caught and eaten by large fish they are \_\_\_\_
4. The process of making food with energy from the sun
6. An animal, like a crab, that eats dead stuff
7. Phytoplankton → zooplankton → little fish → big fish → eagle
9. Something that makes its own food, like a plant
11. Eagles and orcas catch animals to eat, so they are called \_\_\_\_
13. Barnacles, clams, and baleen whales are this kind of eater
15. Seaweeds
16. Seasonal movement from one place to another
17. A place where fresh river water mixes with salty sea water

## Down

1. Tiny organisms that float freely in the water
2. This can't produce its own food, so it eats plants or other animals
3. This phytoplankton has one cell and a tiny shell
5. An animal without a backbone
8. The place where an animal or plant lives
10. What happens here can affect the water that runs into the estuary
12. The tangled mass of seaweeds and organisms washed ashore
14. Bits of dead plants and animals

## Use These Words

algae  
consumer  
detritus  
diatom  
filter feeder  
food chain  
habitat  
invertebrate  
migration  
photosynthesis  
plankton  
predators  
prey  
producer  
estuary  
scavenger  
wrack  
watershed



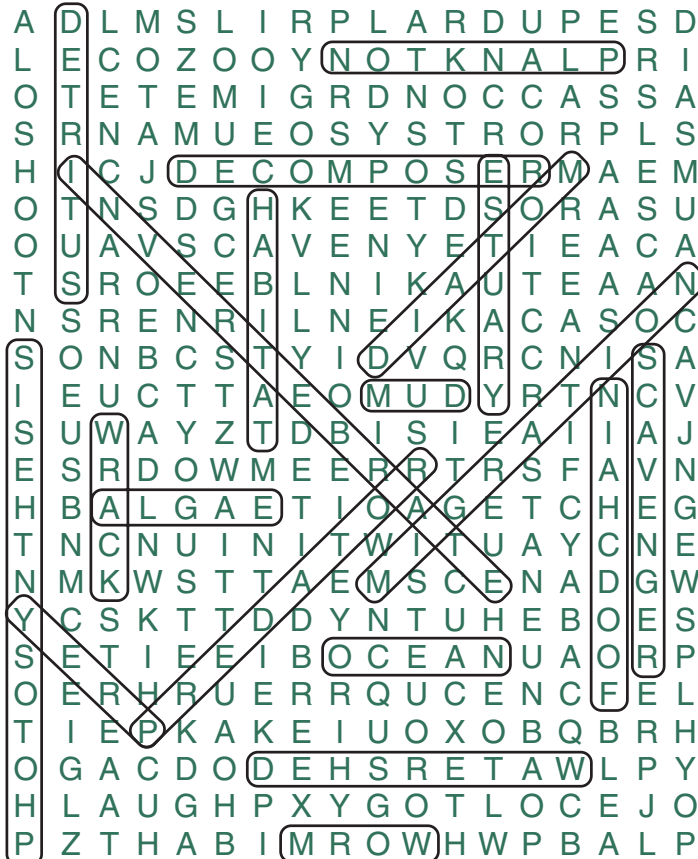
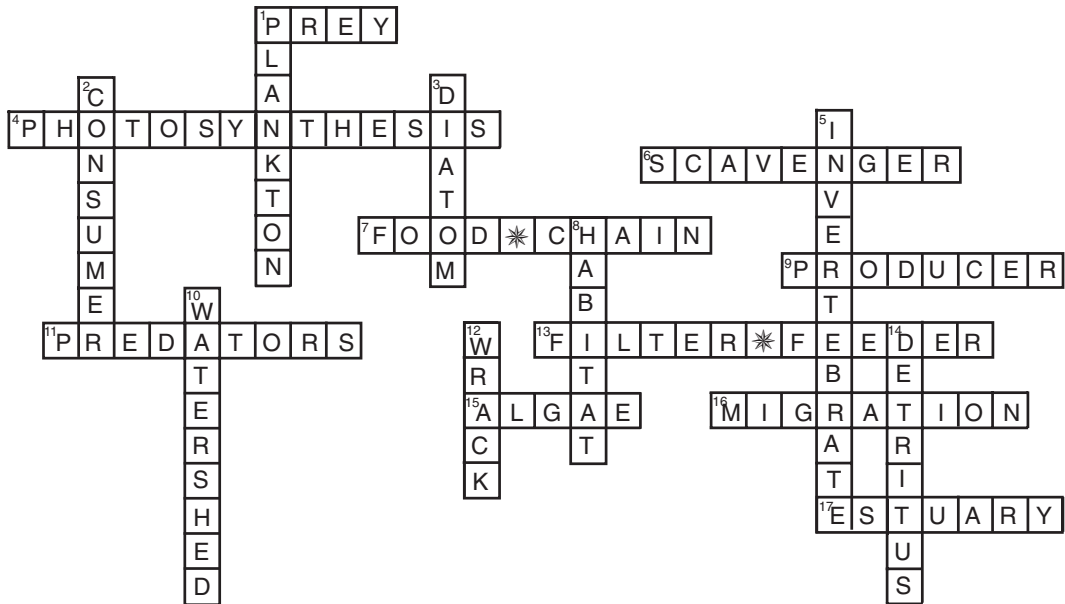
## Estuary Word Search

A D L M S L I R P L A R D U P E S D  
L E C O Z O O Y N O T K N A L P R I  
O T E T E M I G R D N O C C A S S A  
S R N A M U E O S Y S T R O R P L S  
H I C J D E C O M P O S E R M A E M  
O T N S D G H K E E T D S O R A S U  
O U A V S C A V E N Y E T I E A C A  
T S R O E E B L N I K A U T E A A N  
N S R E N R I L N E I K A C A S O C  
S O N B C S T Y I D V Q R C N I S A  
I E U C T T A E O M U D Y R T N C V  
S U W A Y Z T D B I S I E A I I A J  
E S R D O W M E E R R T R S F A V N  
H B A L G A E T I O A G E T C H E G  
T N C N U I N I T W I T U A Y C N E  
N M K W S T T A E M S C E N A D G W  
Y C S K T T D D Y N T U H E B O E S  
S E T I E E I B O C E A N U A O R P  
O E R H R U E R R Q U C E N C F E L  
T I E P K A K E I U O X O B Q B R H  
O G A C D O D E H S R E T A W L P Y  
H L A U G H P X Y G O T L O C E J O  
P Z T H A B I M R O W H W P B A L P

ALGAE	INVERTEBRATE	PREDATOR
DECOMPOSER	MIGRATION	PREY
DETRITUS	MUD	SCAVENGER
DIATOM	OCEAN	WATERSHED
ESTUARY	PHOTOSYNTHESIS	WORM
FOOD CHAIN	PLANKTON	WRACK
HABITAT		



## Puzzle Keys





## Writing an Estuary Story

Write the best story you can using all of the words below. Be sure you know what they mean, then be creative!

**estuary**

**plankton**

**phytoplankton**

**zooplankton**

**detritus**

**habitat**

**food chain**

**watershed**

**photosynthesis**

**producer**

**consumer**

**predator**

**prey**

**decomposer**

**scavenger**

**algae**

**diatoms**

**filter feeder**

**food web**

**invertebrate**

**migration**

**wrack**





## Learning About Tides and Tables

As a class, take a look at a tide table (available at hardware and sporting goods stores, and in some phone books.)

1. Estimate what the tide will be at 11:00 A.M. on the day of your trip to the beach. \_\_\_\_\_ Will it be going in or out? \_\_\_\_\_
2. The tidal range is the distance between the highest and lowest tides. Look at the May tide table, and find three consecutive days with a large tidal range. Now find three days with a small tidal range. Do the same for June. What is the pattern? \_\_\_\_\_
3. Look for times of low tide in June and times of low tide in December. What is the pattern? \_\_\_\_\_
4. If you are planning a trip to Padilla Bay, this is what you might expect to find.
  - 2' to 0' tide - - the bay is nearly empty.
  - 0' to 2' tide - - large area of mud flat exposed.
  - 2' to 4' tide - - small amount of mud flat exposed.
  - 4' to 6' tide -- sandy beach and cobble.
  - 6' to 8' tide -- narrow beach

What should you expect to see when your class is at the beach?

5. As a class, discuss how tides affect the animals that live in the estuary. How do different plants and animals deal with the changing tide? List:
  - Animals that leave the bay at low tide.
  - Animals that may come to the bay at low tide.
  - Animals that close up at low tide.
  - Animals that hide under rocks at low tide.
  - Animals that burrow into the mud at low tide.

### **Bonus**

What causes the tides?

What do you need in order to dig clams in December?





## Make a Food Chain

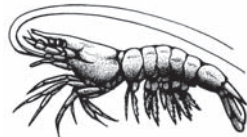
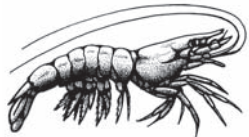
Each of the strips below makes a link in a food chain. Cut on the dotted lines and tape or staple the links together in the order you think is correct, beginning with the "producer."

Then start adding links of your own. As you add estuary eaters, your chain will quickly become a **food web**.

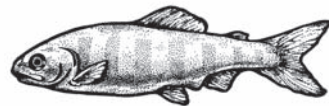
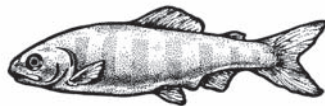
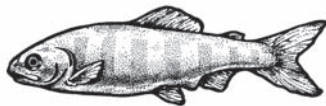
Extra: Add a link that says "Me" to a link that you like to eat.



**Shrimp**



**Salmon**



**Zooplankton**



**Phytoplankton**



**Eagle**





## Make a Food Chain

A series of eight horizontal dashed lines for writing, each flanked by a gray circle on the left and a gray circle on the right.